Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Engineering 51 (2013) 92 – 100

Procedia Engineering

www.elsevier.com/locate/procedia

Chemical, Civil and Mechanical Engineering Tracks of 3rd Nirma University International Conference on Engineering (NUiCONE-2012)

Analysis and Design of Diagrid Structural System for High Rise Steel Buildings

Khushbu Jani[a] , Paresh V. Patel[b]*

[a]*Postgraduate Student , Department of Civil Engineering, Nirma University, Ahmedabad 382481, India*
[b]*Professor , Department of Civil Engineering, Nirma University, Ahmedabad 382481, India*

Abstract

Advances in construction technology, materials, structural systems and analytical methods for analysis and design facilitated the growth of high rise buildings. Structural design of high rise buildings is governed by lateral loads due to wind or earthquake. Lateral load resistance of structure is provided by interior structural system or exterior structural system. Usually shear wall core, braced frame and their combination with frames are interior system, where lateral load is resisted by centrally located elements. While framed tube, braced tube structural system resist lateral loads by elements provided on periphery of structure. It is very important that the selected structural system is such that the structural elements are utilized effectively while satisfying design requirements. Recently diagrid structural system is adopted in tall buildings due to its structural efficiency and flexibility in architectural planning. Compared to closely spaced vertical columns in framed tube, diagrid structure consists of inclined columns on the exterior surface of building. Due to inclined columns lateral loads are resisted by axial action of the diagonal compared to bending of vertical columns in framed tube structure. Diagrid structures generally do not require core because lateral shear can be carried by the diagonals on the periphery of building. Analysis and design of 36 storey diagrid steel building is presented. A regular floor plan of 36 m × 36 m size is considered. ETABS software is used for modeling and analysis of structural members. All structural members are designed as per IS 800:2007 considering all load combinations. Dynamic along wind and across wind are considered for analysis and design of the structure. Load distribution in diagrid system is also studied for 36 storey building. Similarly, analysis and design of 50, 60, 70 and 80 storey diagrid structures is carried out. Comparison of analysis results in terms of time period, top storey displacement and inter-storey drift is presented in this paper.

© 2013 The Authors. Published by Elsevier Ltd. Open access under CC BY-NC-ND license.
Selection and peer-review under responsibility of Institute of Technology, Nirma University, Ahmedabad.

Keywords: Diagrid Structural System, High rise buildings, Structural design

1. Introduction

The rapid growths of urban population and consequent pressure on limited space have considerably influenced the residential development of city. The high cost of land, the desire to avoid a continuous urban sprawl, and the need to preserve important agricultural production have all contributed to drive residential buildings upward. As the height of building increase, the lateral load resisting system becomes more important than the structural system that resists the gravitational loads. The lateral load resisting systems that are widely used are: rigid frame, shear wall, wall-frame, braced tube system, outrigger system and tubular system. Recently, the diagrid – Diagonal Grid – structural system is widely used

* Paresh V. Patel. Tel.: +91-02717-241911; fax: +91-02717-241917.
E-mail address: paresh.patel@nirmauni.ac.in

1877-7058 © 2013 The Authors. Published by Elsevier Ltd. Open access under CC BY-NC-ND license.
Selection and peer-review under responsibility of Institute of Technology, Nirma University, Ahmedabad.
doi:10.1016/j.proeng.2013.01.015

for tall steel buildings due to its structural efficiency and aesthetic potential provided by the unique geometric configuration of the system [5].

Diagrid is a particular form of space truss. It consists of perimeter grid made up of a series of triangulated truss system. Diagrid is formed by intersecting the diagonal and horizontal components. The famous examples of diagrid structure all around the world are the Swiss Re in London, Hearst Tower in New York, Cyclone Tower in Asan (Korea), Capital Gate Tower in Abu Dhabi and Jinling Tower in China as shown in Fig 1. The new headquarter for Central China Television (CCTV) in Beijing is one of the examples of utilization of diagrid structural system to support the challenging shape [4].

(a) (b) (c) (d) (e)

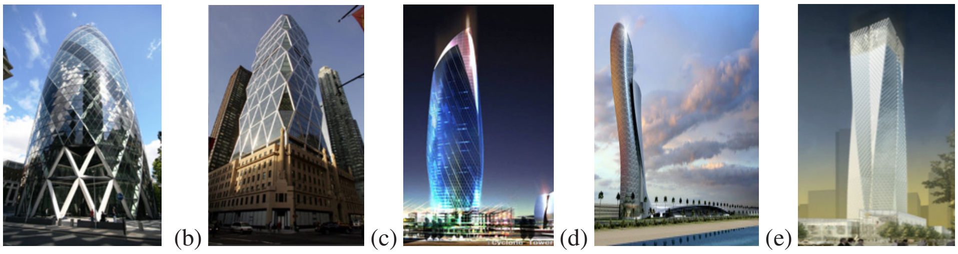

Fig. 1. Diagrid buildings (a) Swiss Re in London (b) Hearst Tower in New York (c) Cyclone Tower in Asan (Korea) (d) Capital Gate Tower in Abu Dhabi and (e) Jinling Tower in china.

Diagrid has good appearance and it is easily recognized. The configuration and efficiency of a diagrid system reduce the number of structural element required on the façade of the buildings, therefore less obstruction to the outside view. The structural efficiency of diagrid system also helps in avoiding interior and corner columns, therefore allowing significant flexibility with the floor plan. Perimeter “diagrid” system saves approximately 20 percent of the structural steel weight when compared to a conventional moment-frame structure [4].

The diagonal members in diagrid structural systems can carry gravity loads as well as lateral forces due to their triangulated configuration. Diagrid structures are more effective in minimizing shear deformation because they carry lateral shear by axial action of diagonal members. Diagrid structures generally do not need high shear rigidity cores because lateral shear can be carried by the diagonal members located on the periphery [2].

In this paper analysis and design of 36 storey diagrid steel building is presented. A regular floor plan of 36 m × 36 m size is considered. ETABS software is used for modeling and analysis of structural members. All structural members are designed as per IS 800:2007 considering all load combinations. Dynamic along wind and across wind are considered for analysis and design of the structure. Similarly, analysis and design of 50, 60, 70 and 80 storey diagrid structures is carried out. Comparison of analysis results in terms of time period, top storey displacement and inter-storey drift is presented.

2. Analysis and design of 36 storey building

2.1. Building configuration

The 36 storey tall building is having 36 m × 36 m plan dimension. The storey height is 3.6 m. The typical plan and elevation are shown in Fig 2. In diagrid structures, pair of braces is located on the periphery of the building. The angle of inclination is kept uniform throughout the height. The inclined columns are provided at six meter spacing along the perimeter. The interior frame of the diagrid structures is designed only for gravity load. The design dead load and live loads on floor slab are 3.75 kN/m^2 and 2.5 kN/m^2 respectively. The dynamic along wind loading is computed based on the basic wind speed of 30 m/sec and terrain category III as per IS:875 (III)-1987 (Gust factor method) [6]. Across wind load is computed as discussed by Gu and Quan [1].The design earthquake load is computed based on the zone factor of 0.16, medium soil, importance factor of 1 and response reduction factor of 5 [7]. Modeling, analysis and design of diagrid structure are carried out using ETABS software [9]. For linear static and dynamic analysis the beams and columns is modeled by beam elements and braces are modeled by truss elements. The support conditions are assumed as hinged. All structural members are designed using IS 800:2007[8]. Secondary effect like temperature variation is not considered in the design, assuming small variation in inside and outside temperature.

دریافت فوری ← متن کامل مقاله

ISIArticles
مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات